

2020 Post-Enumeration Survey Independent Listing Operational Assessment

A New Design for the 21st Century

Issued January 20, 2023
Version 1.0
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Executive Summary

The purpose of the 2020 Post-Enumeration Survey (PES) was to measure the coverage of the 2020 Census. The PES was designed to measure the coverage of housing units (HUs) and people—excluding group quarters, people residing in group quarters, and remote areas of Alaska. The PES provides estimates of net coverage and components of coverage including correct enumerations, erroneous enumerations, whole-person census imputations, and omissions.

The 2020 Independent Listing (IL) operation was the first PES field operation conducted. It included IL production, conducted from January 16 to March 13, 2020, and the IL quality control (QC), conducted from January 23 to March 20, 2020. During IL, field staff independently visited and listed all HUs and potential HUs in each PES sample basic collection unit (BCU) without using any previously collected address information. A potential HU is a unit that is not an HU at the time of listing but has the potential to be an HU on Census Day (April 1, 2020). Commercial units and group quarters should not have been listed.

Before IL, the first PES operation was the sampling of basic collection units (BCUs) for IL. The frame contained all BCUs in the 50 states, District of Columbia (the 50 states and the District of Columbia are referred to in this document as stateside), and Puerto Rico. In the selected BCUs, the IL operation was conducted using the Listing and Mapping Application (LiMA) on laptops.

A subset of IL production BCUs were selected for IL QC. The QC listers worked a specified number of HUs in the selected BCUs and compared what they saw on the ground to the results of the production listing. Errors were corrected by the QC listers. The LiMA evaluated the errors found by a QC lister to determine if the BCU passed or failed QC and if any additional work was needed by the QC lister.

Results and Conclusions¹

The IL production workload was 10,000 BCUs in total, with a stateside workload of 9,800 BCUs (98.0 percent) and a Puerto Rico workload of 400 BCUs (4.0 percent). Of the 10,000 BCUs, 1,700 BCUs (17.0 percent) had zero HUs listed. The expected number of HUs to list was 579,000. There were 532,000 HUs listed by the end of the IL operation (including IL production and adds and deletes from IL QC), 514,000 HUs (96.6 percent) were listed in stateside and 18,000 HUs (3.4 percent) listed in Puerto Rico. Out of the 532,000 HUs listed, 1,400 HUs (0.3 percent) were listed on military bases. These 1,400 HUs were listed in 30 BCUs. There were no HUs listed on military installations in Puerto Rico.

For sampling, the BCUs were grouped into three size categories based on the expected number of HUs in each BCU as: small (0-2 HUs), medium (3-57 HUs), and large (58+ HUs). The expected number of HUs in a BCU came from the In-Field Address Canvassing Master Address File

¹ Data in this report may not sum to totals because of rounding.

Extracts (MAFXs). Out of the total 10,000 BCUs listed, 22.0 percent were expected to be small, 46.0 percent were expected to be medium, and 34.0 percent were expected to be large at the time of sampling. However, the actual percent of small BCUs from IL was 23.0 percent, the percent of medium BCUs was 51.0 percent, and the percent of large BCUs was 29.0 percent.

During IL, listers asked the respondent at each single-family home and mobile home or trailer if there were any other HUs at the address. More specifically, respondents were asked: “At (address), are there any basement or garage apartments, trailers, or other residences, even if no one is living there now?” With this coverage question in the LiMA, PES aimed to capture those additional HUs that were not clearly marked for the IL listers. Of the respondents at 296,000 HUs that were asked the coverage question, 5,700 respondents responded “Yes.” Of the 5,700 respondents that responded “Yes,” 33.3 percent had three or more additional attached units, 10.5 percent had two additional attached units, 56.1 percent had one additional attached unit, and 0.4 percent had additional detached unit(s).

QC Listers worked 2,200 BCUs and 97,500 HUs during QC. The Sampling, Matching, Review and Coding System (SMaRCS) selected 22.0 percent of all IL production BCUs. The expected sample size for HUs to be worked during QC was 15.0 percent of the production workload. However, the actual proportion of HUs worked during QC was 18.4 percent. The QC workload was selected by BCUs and not selected by HUs, which accounts for the difference in expected versus actual number of HUs. Of the IL listers that had at least one BCU checked in QC, 37.6 percent did not have any failures and 37.6 percent had one BCU fail. If the BCU failed QC, then the QC lister recanvassed the entire BCU.

The IL operation was estimated to cost \$5,394,577 for IL production and \$1,147,608 for IL QC. IL production was under budget by \$1,343,901 (24.9 percent) while IL QC was under budget by \$497,914 (43.4 percent). These estimates were projected based on 2010 productivity rates and workload counts. In 2020, the productivity rates were higher, in part because the 2010 IL was a paper operation. Additionally, the HU workload assumption was larger than the actual number of HUs in 2020 IL.

Recommendations

Based on the goals and scope of the 2020 IL operation, high-level recommendations for the 2030 PES are:

1. **The IL lister training needs to include more examples and difficult scenarios. Training should also clarify how to correct erroneous data entry into the listing devices.** Listers were unable to go back and edit their entries if they realized later there had been a mistake.
2. **There should be a follow-up question in the listing device asking if the additional residence is attached, detached, or both for the IL coverage question, “At (address), are there any basement or garage apartments, trailers, or other residences, even if no**

one is living there now?” It would also be helpful to ask how many additional HUs are at the address.

3. **The listing device should be thoroughly tested to resolve any defects.**
4. **The procedure of collecting paper auxiliary maps in the field should be removed for the 2030 PES because of the low volume collected during the 2020 IL operation.**
Auxiliary maps are publicly available maps of the facilities, such as apartment complexes and mobile homes or trailer parks, provided by the facilities’ managers to help the listers canvass the structures. Allowing listers to take and upload pictures or images into the listing instrument may be a more economical option.
5. **Increase the flexibility of QC sampling and monitoring. To help identify and correct some of the potential data quality and QC workload issues, we should implement methods and systems that allow changing QC sampling parameters as needed. Parameters should be easily changed and not hard coded. There should also be flexibility to place specific BCUs into QC for special situations.**
6. **Research is needed into ways to update either the listing instrument, the lister training, or both to help listers correctly identify the BCU boundaries.**

1. Introduction

The purpose of the 2020 Post-Enumeration Survey (PES) was to measure the coverage of the 2020 Census. The PES was designed to measure the coverage of housing units (HUs) and people—excluding group quarters, people residing in group quarters, and remote areas of Alaska. The PES provided estimates of net coverage and components of coverage including correct enumerations, erroneous enumerations, whole-person census imputations, and omissions. Since the PES was an evaluation, the results did not affect the 2020 Census results.

This assessment report focuses on the Independent Listing (IL) operation only. Subsequent PES data collection and matching operations are addressed in separate reports. This assessment describes what happened during the IL operation and identifies lessons learned. This assessment produces valuable data for the 2030 PES planning cycle and provides information on the successes and shortcomings of the 2020 PES IL operation.

1.1 Independent Listing Description

Independent Listing Universe Creation

Before IL, the first PES operation was the sampling of basic collection units (BCUs) for IL. BCUs were the smallest units of collection geography for the 2020 Census operations. The frame contained all BCUs in the 50 states, District of Columbia (the 50 states and the District of Columbia are referred to as stateside), and Puerto Rico (PR) that were not in the remote areas of Alaska and not fully covered by water. This list of BCUs was stratified by state, BCU size, tenure, and an American Indian Reservation indicator².

The BCUs were grouped into three size categories: small (0 to 2 HUs), medium (3 to 57 HUs), and large (58 or more HUs). The expected number of HUs for each BCU was derived from the In-Field Address Canvassing Master Address File Extracts (MAFXs). Tenure had two categories: owner and non-owner. BCUs with 40 percent or more of non-owner households were categorized as “non-owner.” BCUs with less than 40 percent of non-owner households were categorized as “owner.” A stratified systematic sample of 10,000 BCUs was selected: 9,800 BCUs in stateside and 400 BCUs in PR. When selecting the initial sample of PES BCUs for IL, large BCUs had a higher selection probability than medium size BCUs because of the anticipated subsequent HU subsampling. For more details on the 2020 PES sample design see Hill et al. (2021).

² There were 30 states with sufficient American Indian population living on American Indian Reservations. For each of these 30 states, an additional stratum was formed. Note that there were American Indian Reservations in other states, but with insufficient American Indian population to support a separate American Indian Reservation stratum.

Independent Listing Operational Procedures

The IL operation was conducted by personal visit using the Listing and Mapping Application (LiMA) on a laptop. Starting with a blank map in LiMA, IL listers canvassed or traveled in a clockwise direction in each PES sample BCU to list all HUs and potential HUs located to their right. A potential HU is a unit that is not an HU at the time of listing but has the potential to be an HU on Census Day. Commercial units and group quarters should not have been listed for IL. On the LiMA, IL listers collected the following information for each HU and potential HU³ in their assigned PES sample BCUs:

- Address information to identify the HU and structure, street name, city, and ZIP Code for units with urban⁴ addresses and for rural addresses when available.
- Rural routes and box numbers for both urban and rural addresses.
- Physical location descriptions.
- Number of HUs in a multiunit structure.
- Classification of each building that contains HUs.⁵
- Status of each unit listed such as occupied or vacant and intended for occupancy, under construction, future construction, unfit for habitation, boarded up, empty trailer lot or site, structure used for storage of household goods, or structure used for another purpose.
- Special features of addresses in PR, such as urbanization or kilometer/hectometer (KM/HM).

IL listers made three attempts to talk to a resident at each unit before contacting a proxy and listed units by observation only when necessary. A proxy could be a neighbor, landlord, or building manager. A postal worker was not allowed to be a proxy. In a multiunit structure, the lister canvassed by observation first and then attempted to gather and reconcile the information from a manager who may have been able to provide information on all HUs more efficiently than questioning residents of each unit directly. Also, efforts were made to acquire copies of publicly available maps, referred to as auxiliary maps, of apartment complexes, mobile home parks, and recreational vehicle (RV) parks from the managers of these facilities.

To capture extra and hidden units, a lister attempted to contact a respondent at single-family homes and mobile homes or trailers to determine whether there were any additional HUs that may not be obviously visible. The respondent was asked the coverage question: “At (address), are there any basement or garage apartments, trailers, or other residences, even if no one is living there now?” If the respondent answered “Yes,” information about the additional unit was collected.

³ The remainder of this document uses “HUs” to refer to both HUs and potential HUs.

⁴ Urban is a form of address where house number and street name are given (e.g., 123 Blue Jay Road). Rural addresses pertain to all addresses other than urban.

⁵ Classification of a building includes identifying the building as a single-family home; building with two or more apartments; mobile home or trailer (inside or outside of a mobile home park); camper, tent, boat, van; or other.

A map spot is a symbol on the map representing the location of a structure that contains one or more HUs. The map spot represents the structure, not each HU within the structure. In LiMA, IL listers added map spots to the map and collected Global Positioning System (GPS) coordinates for each structure they listed. A multiunit structure has one map spot to represent the entire structure. If there was more than one HU at a map spot, each HU was assigned a within map spot number during post-processing of IL data to uniquely identify the unit. A map spot on a map served as a reference for the IL listers to find the HU in the future. GPS coordinates also helped assign HUs and the people in these HUs to the correct geography.

Units in RV parks, campgrounds, marinas, and other similar locations were listed only if someone with no other usual residence occupied them at the time of listing. In addition, vacant lots in mobile home parks were listed since they could have HUs later when the PES Person Interview (PI) is conducted. If the lister was unsure about whether a unit was an HU, they were instructed to list the address.

The assignment of IL listers to BCUs adhered to strict rules for independence between census and PES operations. To further ensure independence between the census address list and IL address list, there was no previously collected address information given to the IL listers conducting IL.

Independent Listing Quality Control Procedures

After a production lister completed listing an assigned BCU, the data collected from LiMA was delivered to the Sampling, Matching, Review and Coding System (SMaRCS). The quality assurance plan for IL applied a stratified, systematic sampling design to select BCUs for quality control (QC). Based on this sampling strategy, the Decennial Statistical Studies Division (DSSD) estimated that the QC listing workload would include approximately 15.0 percent of the production HUs.

First, SMaRCS checked every BCU for the presence of certain characteristics. These characteristics indicated either the BCU was difficult to list (and likely to contain potential errors) or that the lister may not have been following proper procedures. BCUs with a higher number of these characteristics were more likely to be selected for QC. The screening criteria and scoring from the PES IL quality assurance plan (Roinestad, 2020) are in Table 1.

Table 1 Screening Criteria and Scoring for IL QC		
Condition: BCU Has...	Points	Explanation
More than 20% of HUs are in multiunit structures with five or fewer units.	10	IL listers frequently make errors in multiunit structures with five or fewer units.
An average strand length (distance between manual and GPS coordinates) minus GPS accuracy is more than 450 inches (11.4 meters).	10	The lister appears to be far from the unit they are listing.
An average strand length (distance between manual and GPS coordinates) minus GPS accuracy more than 100 and less than or equal to 450 inches (2.5 meters to 11.4 meters).	5	Lister appears to be away from the unit they are listing, but not as far as the previous criterion.
One or more curbstoning clusters, defined as six or more addresses within 7.6 meters (multiunit structure counts as one address).	20	The lister appears to be listing many HUs from the same physical location, a sign of falsification.
Source: U.S. Census Bureau, Revised Quality Assurance Plan for the 2020 Post-Enumeration Survey Independent Listing Field Operation, DSSD 2020 POST-ENUMERATION SURVEY MEMORANDUM SERIES #2020-D-06R2. Note: Although we specified both the short and long strand check distance parameters in meters, an error in SMarCS meant that it was interpreted as inches. This error did not affect the overall IL QC workload because we based our cutoffs on data from the 2020 In-Field Address Canvassing Operation, which also had the distances calculated in inches instead of meters.		

Each BCU was assigned to one of three sampling strata based on specific characteristics (see Table 1). BCUs that were determined to be more difficult to list were assigned to strata with higher sampling rates. BCUs in the high stratum were sampled at a 100 percent rate, while BCUs in the middle and low strata were selected at a 20 percent and 10 percent sampling rate, respectively. The stratum classifications are provided in Table 2.

Table 2 QC Sampling Strata		
Stratum	Points	Sampling Rate
High	20+	100%
Middle	1-19	20%
Low	0	10%
Source: U.S. Census Bureau, Revised Quality Assurance Plan for the 2020 Post-Enumeration Survey Independent Listing Field Operation, DSSD 2020 POST-ENUMERATION SURVEY MEMORANDUM SERIES #2020-D-06R2.		

Once a BCU was selected for QC in SMarCS, a QC lister checked the BCU in the field. QC listers worked a specified number of HUs determined by the within-BCU sampling plan, shown in Table 3. QC listers compared what they saw on the ground to the results of the production listing, correcting errors as they encountered them. The LiMA then evaluated the errors found

by the QC listers, classifying them as critical or minor. If a lister made three or more minor errors for a single listed HU, then they would be cumulatively counted as a single critical error. If the number of critical errors in a BCU was less than or equal to the number of allowable critical errors for the BCU, then the BCU passed QC. Otherwise, the BCU failed QC, which resulted in the QC lister recanvassing the entire BCU.

Table 3 Within-BCU Sampling Plan and Number of Allowable Critical Errors		
Range of BCU Sizes (Number of HUs)	Sample Size (Number of HUs)	Number of Allowable Critical Errors
$x \leq 20$	all	0
$20 < x \leq 70$	20	0
$70 < x \leq 105$	35	1
$105 < x \leq 245$	40	1
$245 < x \leq 525$	50	2
$x > 525$	65	3
Source: U.S. Census Bureau, Revised Quality Assurance Plan for the 2020 Post-Enumeration Survey Independent Listing Field Operation, DSSD 2020 POST-ENUMERATION SURVEY MEMORANDUM SERIES #2020-D-06R2.		

For more information on IL QC, see Roinestad (2020).

1.2 Operational Changes Resulting from COVID-19

There were no operational changes to the IL production or IL QC because of the COVID-19 pandemic. The operation was completed before COVID-19 impacted 2020 Census operations.

1.3 Schedule

A subset of milestone activities for the IL operation from the final baselined version of 2020 Census Integrated Master Schedule is shown in Table 4.

Table 4 Milestone Activities for the IL Operation				
Activity or Milestone Name	Planned Start	Actual Start	Planned Finish	Actual Finish
Develop PES IL LiMA Requirements	04/19/2018	04/19/2018	05/31/2018	05/31/2018
Conduct Systems and Verification Project Level Testing for IL Production and IL QC	04/01/2019	05/07/2019	06/07/2019	02/06/2020*
Train IL Listers	01/02/2020	01/02/2020	01/16/2020	01/16/2020
Conduct IL Production	01/16/2020	01/16/2020	03/13/2020	03/13/2020
Conduct IL QC	01/23/2020	01/23/2020	03/20/2020	03/20/2020
*Testing continued after production started.				
Source: U.S. Census Bureau, 2020 Census Integrated Master Schedule.				

2. Background

The 2020 PES was a complex survey conducted independently of the 2020 Census. For information on the entirety of the 2020 PES design, see Kennel (2018) and the U.S. Census Bureau (2020).

The 2020 PES included five field data collection operations and numerous sampling, matching, and estimation operations. This assessment includes only the IL field operation, all other operations are covered in separate assessment reports. The five PES field data collection operations were:

1. **PES IL Operation** (January 16 – March 20, 2020) – To briefly recap, in the BCUs selected in the first phase of sampling, the IL was conducted by personal visit using the LiMA instrument. IL listers listed all HUs and potential HUs in each PES sample BCU, starting from a clean slate without previous HU information. Information about the number of HUs in a particular structure was also collected.
2. **PES Initial Housing Unit Followup (IHUFU) Operation** – After the IL operation, the Initial Housing Unit Matching operation matched the results of the IL to the preliminary census address list. The addresses that needed additional information were sent to the IHUFU operation. Listers conducted a paper-based IHUFU operation using a questionnaire with questions tailored to resolve any remaining issues between addresses from IL and the census address list, such as nonmatches or possible matches. This operation collected information needed to accurately determine the match status of HUs that had an unresolved match status. Possible duplicates and IL addresses where the listers indicated that the units had a status other than occupied or vacant at the time of listing were also contacted.
3. **PES PI Operation** – Interviewers contacted selected HUs in the PES sample BCUs. They conducted interviews using an automated instrument, in person or by telephone, to collect information on who lived there at the time of the interview, where else they usually lived or stayed, who lived there on Census Day (April 1, 2020), where else they could have been counted on Census Day, and whether anyone else lived at the address on Census Day who did not live there at the time of the interview.
4. **PES Person Followup (PFU) Operation** – The Person Matching operation followed the PI operation. The people that needed additional information were sent to PFU. PFU was conducted by personal visit using a paper questionnaire. PFU interviewers contacted people with unresolved residence status (to get more information about where the person was living) or unresolved enumeration status (to get more information about where the person should have been counted in the census), even when they may have been matched, to resolve any issues between the PES PI and the census in the PES sample BCUs. People that were a possible match or possible duplicate were also contacted.

5. **PES Final Housing Unit Followup (FHUFU) Operation** – FHUFU was the last field operation for the PES. Information was collected to accurately determine the match status of HUs that had an unresolved match status during the Final Housing Unit Matching operation. The addresses from the final census address file (i.e., the Census Unedited File [CUF]) were matched against the PES IL address list. The CUF included additional addresses that were not on the preliminary census address list used in the earlier phases of the PES. There were also addresses that were on the preliminary census address list, but not on the CUF. Interviewers conducted a paper-based FHUFU operation using questionnaires tailored to resolve any remaining issues between addresses from PES IL and the CUF. The issues included nonmatches, possible matches, possible duplicates, surrounding BCU matches, and HUs listed by PES that matched to census group quarters.

Each field operation had its own QC component in which field staff conducted a quality check of a sample of production work. The QC operations typically started one week after the start of production and ended one week after production was completed.

2010 Independent Listing Operation

In the 2010 Census, the post-enumeration survey was known as Census Coverage Measurement (CCM) survey. The operational design of the 2020 PES is very much like that of the 2010 CCM. The 2010 CCM IL operation was conducted in the same manner as described in the Introduction section for the 2020 PES, with a few changes. The 2010 CCM IL operation did not use the LiMA instrument. The operation was conducted on paper using a book referred to as the Independent Listing Book. The 2010 CCM IL operation had three waves of data collection, whereas the 2020 PES IL only had one wave. See Argarin et al. (2012) for more information on 2010 CCM IL waves.

Block clusters were sample geographical areas, selected for the 2010 CCM survey, containing one or more adjacent collection blocks. Their role was analogous to the role of BCUs in the 2020 PES. In 2010, the IL workload consisted of 12,364 block clusters or 18,165 collection blocks (Argarin et al., 2012). Within these block clusters, 960,041 HUs were listed. 2,757 of the 12,364 block clusters (22.3 percent) had at least one block with zero HUs. Of the 12,364 block clusters listed, 3,999 block clusters were subsampled out following IL as part of a sample reduction decision. Only 8,365 block clusters and 557,640 HUs remained in sample and continued into the next 2010 CCM operation (Davis, 2012).

An issue that arose from the 2010 CCM IL operation was confusion about the use of the coverage question: “At (address), are there any basement or garage apartments, trailers, or other residences, even if no one is living there now?” There was discussion around keeping or dropping this question, so the effectiveness of this question was measured in 2010. There were 3,973 units added because of this question.

The intent of the IL operation was to collect as much address information as possible for an HU to enable an interviewer to return to that HU during the PI operation and for matchers to match to the census addresses. Some HUs, especially in rural areas, did not have typical basic street address component of house number and street name. In 2010, 4.2 percent of rural addresses did not have a house number or street name. In contrast, only 0.1 percent of urban addresses did not have these fields.

The data collection was managed in the field from 12 regional census centers (RCCs) during the 2010 Census. The number of RCCs was reduced to six after the completion of the 2010 Census.

2018 End-to-End Census Test

The 2018 End-to-End Census Test examined and validated the 2020 Census operations, procedures, systems, and field infrastructure to ensure proper integration and conformance with functional and nonfunctional requirements. The 2020 PES IL operation was originally scheduled to be a part of this test, but it was descoped because of lack of funding. There was no testing of the IL operation in the field before going live on January 16, 2020.

3. Methodology

All 2020 Census operational assessments share a similar methodology. In general, they provide details about the implementation of individual operations and processes (including final volumes, rates, and costs) by presenting data from production systems, files, and activity reports, in addition to information collected from lessons learned and debriefings sessions. These important measures are key ingredients to defining successful completion of the 2020 Census operations and processes. Typical categories of success measures are as follows:

- **Process Measures** that indicate how well the process works, typically including measures related to completion dates, rates, and productivity rates.
- **Cost Measures** that drive the cost of the operation and comparisons of actual costs to planned budgets. Costs can include workload as well as different types of resource costs.
- **Quality Measures** of operational results, typically including things such as rework rates, error rates, and coverage rates.

In addition to planning and managing the implementation of its operation, each Integrated Project Team (IPT) had the responsibility of determining the assessment questions for its operation. In consultation with the Decennial Research Objectives and Methods (DROM) Working Group, each IPT developed assessment questions tailored to the uniqueness of its operation that would yield the most useful information to those planning similar operations in the future. Assessment questions provide the framework for the Results section appearing in each operational assessment report.

The sections that follow present the assessment questions for this operation and describe the sources of information used to answer them. Please note that the numbers appearing in this operational assessment report have been subjected to the U.S. Census Bureau's approved disclosure avoidance techniques including noise injection and rounding.⁶

3.1 Assessment Questions

The following research questions will be answered to summarize and assess the IL operation.

1. Workloads and workflow results
 - a. How many BCUs were included in IL production by regional census center (RCC) and how many of those were selected for IL QC? What was the distribution of total HUs listed, grouped by actual BCU size and expected BCU size?
 - b. What was the unit status distribution?
 - c. How often did the coverage question result in additional HUs (i.e., extra and hidden units) being listed?
 - d. How many HUs required within map spotting?
 - e. How many HUs were listed with both house number and street name, only house number, only street name, or neither? How many HUs had a unit designation?
 - f. What was the total number of HUs listed on military installations?
 - g. How many auxiliary maps were collected in the IL operation?
 - h. What was the production rate (i.e., HUs listed per hour)?
 - i. What was the number of field staff (listers and census field supervisors [CFSs]) planned and actual number of field staff hired and trained?
 - j. What was the summary of the QC components for IL?
 - k. What percentage of IL listers had at least one BCU checked in IL QC? What was the distribution of the count of failed BCUs by number of IL listers?
2. Schedule and cost results
 - a. How did actual start and completion dates compare with planned start and completion dates?
 - b. Were the IL production and IL QC over or under budget?
3. Lessons Learned by the PES IPT
 - a. What would the PES IPT change about the implementation of the 2020 PES IL operation?
 - b. What major challenges does the PES IPT foresee affecting the implementation of the IL operation in the future?

3.2 Data Sources and Calculations: Production Systems and Reports

Information collected during the IL operation on the LiMA instrument was sent to the Master Address File – Topologically Integrated Geographic Encoding and Referencing (MAF-TIGER)

⁶ Data in this report may not sum to totals because of rounding.

team. The MAF-TIGER team used the data from IL to create the PES MAFX files. There was one PES MAFX BCU-level file for each of the BCUs with HUs or potential HUs. These files were delivered to the DSSD servers where they were used to answer the research questions. In addition to the PES MAFX data, a PES sample design file was used to supplement the PES MAFX data in answering the questions. Sample design file contained data from the BCU sampling frame for in-sample BCUs only. For IL QC, DSSD analyzed data from the SMarCS.

3.3 Lessons Learned and Debriefing Sessions

The 2020 PES IL debriefing questionnaire survey was taken on the Learning Monitoring System by the 2020 PES IL listers and CFSs for IL production and IL QC. This survey was taken at the end of the IL operation from March 2 to March 20, 2020. The questions in the survey consisted of multiple choice and write-in answers.

In addition to the lister and CFS debriefings, there was a debriefing of the RCC management. This debriefing was held on March 25, 2020, through teleconference. Each region had a spokesperson. The debriefing responses include each region's written submission and what was discussed during the teleconference.

The PES Field Operations IPT was given an opportunity to provide lessons learned through an online survey through SharePoint.

4. Limitations

Unlike 2010, the use of the LiMA limited our ability to collect certain HU information. The LiMA instrument was already in use by other operations and DSSD could only make limited changes to the existing functionality because of resources. The device did not have a question about whether the additional residence to the main residence captured by the coverage question was attached or detached. Therefore, DSSD had to make assumptions to determine whether an additional unit was attached or detached. If the number of additional units at the structure was zero, but the respondent said they had additional units, then it was assumed that any added units were detached. There could be multiple detached units at the property, but DSSD was not able to determine how many, only that there was at least one. If there were additional units at the structure, then it was assumed that any added units were attached.

Results are not shown broken out by urban and rural BCUs. In 2010, Geography Division provided DSSD with the information about whether a block cluster was urban or rural. The data were not available for 2020 BCUs.

The information provided by the Unified Tracking System (UTS) for the questions about the fieldwork hours and fieldwork costs was not broken down to the level of detail outlined in the study plan. The data for budgeted and actual HUs listed and the budgeted and actual total cost

per BCU for lister and CFS positions were not available, which limited the ability to analyze the relevant study plan questions for this assessment.

5. Results

Table 5 has summary IL data for stateside and PR. The IL workload consisted of 10,000 BCUs and the IL QC workload consisted of 2,200 BCUs. Of the 10,000 BCUs, 8,600 BCUs (86.0 percent) had one or more HUs listed and 1,700 BCUs (17.0 percent) had zero HUs listed. Of the 8,600 BCUs with HUs, 8,200 BCUs were stateside and 350 were in PR. There were 532,000 HUs within the 8,600 BCUs, with 514,000 HUs in stateside and 18,000 HUs in PR.

Table 6 shows the IL data for each state, District of Columbia, and PR. The number and percent of BCUs selected for the IL operation and the number of HUs listed are displayed in this table. California has the highest number of BCUs selected for IL (850 BCUs), followed by Texas (750 BCUs). Similarly, California has the highest number of IL HUs (57,500 HUs), followed by Texas (43,500 HUs).

Table 5 The 2020 PES IL Operation Summary Data			
BCUs and HUs	Stateside	PR	Total
Total BCUs	9,800	400	10,000
BCUs with Zero HUs	1,600	70	1,700
BCUs with One or More HUs	8,200	350	8,600
Total HUs (Including IL Production and IL QC)*	514,000	18,000	532,000
*During IL QC, QC listers updated the list of HUs from IL production including adding and deleting HUs. Counts may not sum correctly because of rounding. Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, PES MAFxs.			

Table 6 The 2020 PES IL Operation Summary Data by State				
State	Number of BCUs	Percent of BCUs	Number of HUs	Percent of HUs
Alabama	150	1.5%	5,000	0.9%
Alaska	60	0.6%	2,500	0.5%
Arizona	300	3.0%	13,000	2.4%
Arkansas	100	1.0%	3,400	0.6%
California	850	8.5%	57,500	10.8%
Colorado	150	1.5%	7,800	1.5%
Connecticut	80	0.8%	5,500	1.0%
Delaware	50	0.5%	3,400	0.6%
District of Columbia	40	0.4%	6,100	1.1%
Florida	550	5.5%	39,500	7.4%
Georgia	300	3.0%	18,500	3.5%
Hawaii	150	1.5%	22,000	4.1%
Idaho	80	0.8%	2,500	0.5%
Illinois	350	3.5%	16,000	3.0%
Indiana	200	2.0%	6,700	1.3%
Iowa	100	1.0%	2,900	0.5%
Kansas	100	1.0%	2,200	0.4%
Kentucky	150	1.5%	6,000	1.1%
Louisiana	150	1.5%	6,000	1.1%
Maine	70	0.7%	2,100	0.4%
Maryland	150	1.5%	10,000	1.9%
Massachusetts	150	1.5%	10,500	2.0%
Michigan	250	2.5%	9,500	1.8%
Minnesota	200	2.0%	6,900	1.3%
Mississippi	100	1.0%	3,400	0.6%
Missouri	200	2.0%	7,300	1.4%
Montana	100	1.0%	2,300	0.4%
Nebraska	80	0.8%	1,600	0.3%
Nevada	80	0.8%	5,800	1.1%
New Hampshire	60	0.6%	2,800	0.5%
New Jersey	200	2.0%	13,000	2.4%
New Mexico	200	2.0%	3,600	0.7%
New York	450	4.5%	37,500	7.0%
North Carolina	300	3.0%	16,500	3.1%
North Dakota	90	0.9%	2,800	0.5%
Ohio	300	3.0%	14,000	2.6%
Oklahoma	150	1.5%	4,100	0.8%
Oregon	150	1.5%	7,000	1.3%
Pennsylvania	350	3.5%	13,000	2.4%

State	Number of BCUs	Percent of BCUs	Number of HUs	Percent of HUs
Rhode Island	50	0.5%	2,500	0.5%
South Carolina	150	1.5%	8,700	1.6%
South Dakota	100	1.0%	2,600	0.5%
Tennessee	200	2.0%	9,500	1.8%
Texas	750	7.5%	43,500	8.2%
Utah	90	0.9%	4,800	0.9%
Vermont	60	0.6%	2,000	0.4%
Virginia	250	2.5%	14,500	2.7%
Washington	200	2.0%	13,500	2.5%
West Virginia	80	0.8%	2,400	0.5%
Wisconsin	200	2.0%	6,800	1.3%
Wyoming	80	0.8%	2,400	0.5%
Puerto Rico	400	4.0%	18,000	3.4%
Total	10,000	100.0%	532,000	100.0%
Row and column percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding.				
Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, PES MAFxs.				

1. Workloads and workflow results

- a. How many BCUs were included in IL production by RCC and how many of those were selected for IL QC? What was the distribution of total HUs listed, grouped by actual BCU size and expected BCU size?

All PES sample BCU assignments were released to the field to start work at once. IL listers identified and listed all HUs and potential HUs located inside the boundaries of their assigned BCUs. There was a total of 10,000 BCUs selected for the IL operation and worked in IL production. 2,200 of these BCUs (22.0 percent) were selected for IL QC and 97,500 HUs (18.4 percent) were worked in IL QC. There were 400 BCUs (4.0 percent overall) selected for IL production in PR and 100 of these BCUs (25.0 percent) were selected for IL QC. The QC workload was based on the selection of BCUs and not the selection of HUs. Although PR is part of the New York RCC, the PR numbers are shown separately in Table 7. The Dallas RCC had a larger share of BCUs in IL production (22.0 percent) and IL QC (18.2 percent).

Table 7 The 2020 PES IL Operation IL Production and IL QC BCUs by RCC					
RCC (RCC Number)	IL Production		IL QC		
	Count	Percent	Count	Percent	Percent Selected for QC
New York (22; Excluding PR)	1,100	11.0%	300	13.6%	27.3%
Philadelphia (23)	1,600	16.0%	300	13.6%	18.8%
Chicago (25)	1,600	16.0%	300	13.6%	18.8%
Atlanta (29)	1,700	17.0%	300	13.6%	17.6%
Dallas (31)	2,200	22.0%	400	18.2%	18.2%
Los Angeles (32)	1,600	16.0%	350	15.9%	21.9%
Total Stateside BCUs	9,800	98.0%	2,000	90.9%	20.4%
PR	400	4.0%	100	4.5%	25.0%
Total BCUs (Stateside and PR)	10,000	100.0%	2,200	100.0%	22.0%
Row and column percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding. Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, PES MAFXs.					

The expected number of HUs in a BCU came from the MAFXs used for the 2020 Census In-Field Address Canvassing operation. These HU counts were put on a sample design file for those BCUs selected into sample for IL. The actual number of HUs in a BCU came from the data collected during the IL operation included on the PES MAFXs.

Table 8 has the distribution of IL BCUs by the actual and expected sizes of the BCUs. Out of the total 10,000 BCUs, 22.0 percent were expected to be small (0-2 HUs), 46.0 percent were expected to be medium (3-57 HUs), and 34.0 percent were expected to be large (58+ HUs). However, the actual percent of small BCUs from IL was 23.0 percent, the percent of medium BCUs was 51.0 percent, and the percent of large BCUs was 29.0 percent. Of the 2,300 small stateside and PR BCUs with two or less HUs listed from IL, 2,000 BCUs (87.0 percent) were expected to be small, 200 BCUs (8.7 percent) were expected to be medium, and 60 BCUs (2.6 percent) were expected to be large at time of sampling. There were also differences between actual and expected in the medium and large size categories.

Table 8
The 2020 PES IL Operation
Distribution of BCUs by Actual and Expected Sizes of the BCUs

Actual Size of BCU from IL	Total		Expected Size of BCU					
			Small (0-2 HUs)		Medium (3-57 HUs)		Large (58+ HUs)	
	Count	Column Percent	Count	Row Percent	Count	Row Percent	Count	Row Percent
Stateside	9,800	98.0%	2,100	21.4%	4,500	45.9%	3,200	32.7%
0-2 HUs	2,200	22.4%	1,900	86.4%	200	9.1%	60	2.7%
3-57 HUs	4,900	50.0%	200	4.1%	4,200	85.7%	450	9.2%
58+ HUs	2,800	28.6%	N<15	0.0%	50	1.8%	2,700	96.4%
PR	400	4.0%	100	25.0%	150	37.5%	150	37.5%
0-2 HUs	100	25.0%	90	90.0%	N<15	0.0%	N<15	0.0%
3-57 HUs	200	50.0%	30	15.0%	100	50.0%	30	15.0%
58+ HUs	100	25.0%	N<15	0.0%	N<15	0.0%	100	100.0%
Total (Stateside and PR)	10,000	100.0%	2,200	22.0%	4,600	46.0%	3,400	34.0%
0-2 HUs	2,300	23.0%	2,000	87.0%	200	8.7%	60	2.6%
3-57 HUs	5,100	51.0%	200	3.9%	4,400	86.3%	500	9.8%
58+ HUs	2,900	29.0%	N<15	0.0%	50	1.7%	2,800	96.6%

Row and column percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding.
Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, PES MAFXs, BCU Control File, PES Sample Design File v1.

b. What was the unit status distribution?

IL listers assigned a unit status for each unit that they listed in their BCUs. The eight possible statuses were:

- **HU** – The unit was a house, apartment, mobile home or trailer, group of rooms, or single room with direct access and occupied as a separate residence from the main structure. If vacant, it must have been intended for occupancy as a separate HU. Unconventional housing, such as tents, railroad cars, vehicles, caves, and RVs, were considered HUs only if they were being used as a permanent residence.
- **Uninhabitable HU** – The unit was vacant and open to the elements or was burned out or condemned and because of these conditions was unfit for habitation. There must have been no signs of repairs or reconstruction and no evidence of anyone living there.
- **Under Construction** – The unit was in the process of being built. To be considered under construction, the foundation must have been set, but the windows, doors, and roof must not have been in place yet.

- **Empty Trailer Pad or Mobile Home Site** – A trailer pad or mobile home site in a trailer park or mobile home community was empty. The pad must have had utility hook-ups and be a permanent site.
- **Future Construction** – A unit was a residential construction or planned conversion but has not yet started, such as from a warehouse to apartments.
- **Storage of Household Goods** – A unit that was used primarily for storing household goods but was vacant at the time of visit.
- **Boarded Up** – A unit with windows and doors boarded up with wood or other materials to prevent entry into the building or structure.
- **Other** – This status was assigned when the other HU statuses are not applicable for what was seen on the ground.

If the unit was occupied, but still under construction or boarded up, the lister was instructed to assign a unit status of “HU.” Table 9 provides the distribution of unit status for each unit listed during IL. Because the PR counts were small, Table 9 reports the combined stateside and PR results. 97.7 percent of the listed units had a unit status of “HU” and 2.3 percent were those considered potential HU at time of listing.

Table 9 The 2020 PES IL Operation Distribution of Unit Status for Units Listed		
Unit Status	Unit Listed	
	Count	Percent
HU	520,000	97.7%
Uninhabitable HU	2,500	0.5%
Under Construction	3,800	0.7%
Empty Trailer Pad or Mobile Home Site	1,800	0.3%
Future Construction	1,800	0.3%
Storage of Household Goods	400	0.1%
Boarded Up	850	0.2%
Other	1,200	0.2%
Total HUs	532,000	100.0%
Row and column percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding. Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, PES MAFxs.		

- c. How often did the coverage question result in additional HUs (i.e., extra and hidden units) being listed?

In the LiMA, the coverage question was used to determine whether there were any additional HUs on the property of single-family homes and mobile homes or trailers. This question was included so no HUs were missed. The question is, “At (address), are there any basement or garage apartments, trailers, or other residences, even if no one is living there now?” There were 5,700 “Yes” responses. Because of limitations of the LiMA, some assumptions had to be made in this assessment regarding whether the additional HU was attached or detached.⁷ An attached HU would share a common wall, usually on both sides of the property such as a basement or garage apartment. A detached HU was free of any shared walls and stands alone such as a parent or guest house or a tiny home on the property.

Table 10 shows the number of additional HUs collected during IL because of the “Yes” responses to the IL coverage question for occupied or vacant and intended for occupancy from single-family homes and mobile homes or trailers. Of the 296,000 HUs that were asked the coverage question, 5,700 HUs resulted in additional attached HUs and 20 HUs resulted in additional detached HUs. PES IL listers may not have listed these additional HUs if this question was not asked.

Table 10 The 2020 PES IL Operation Additional HUs Resulting from Responses to the IL Coverage Question for Occupied or Vacant and Intended for Occupancy from Single-Family Homes and Mobile Homes or Trailers										
Location	Number of Additional HUs									
	Detached HU(s)		1 Attached HU		2 Attached HUs		3+ Attached HUs		Total Additional HUs	
	Count	Row Percent	Count	Row Percent	Count	Row Percent	Count	Row Percent	Count	Column Percent
Stateside	20	0.4%	2,600	53.1%	500	10.2%	1,900	38.8%	4,900	86.0%
PR	N<15	0.0%	600	75.0%	100	12.5%	50	6.3%	800	14.0%
Total (Stateside and PR)	20	0.4%	3,200	56.1%	600	10.5%	1,900	33.3%	5,700	100.0%
Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding. Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, PES MAFxs.										

d. How many HUs required within map spotting?

Map spotting refers to marking the location of each HU in LiMA with GPS coordinates. Each HU in LiMA was marked with a map spot to identify the location. If there was more than one HU at a map spot, the HUs were given a within map spot number to uniquely identify the HU. The within map spotting procedures occurred during post-processing of the IL data. This was especially common at multiunit structures where there are several units in one building.

⁷ If the number of additional HUs at the structure was zero, then it was assumed that any added HUs were detached. There could be multiple detached HUs listed at the property, but DSSD was not able to determine how many. If the number of additional HUs at the structure was greater than zero, then it was assumed that any added HUs were attached.

Additionally, map spotting was not allowed at military bases because of security concerns.⁸ The counts listed in Table 11 do not include HUs located on military bases. Out of the 530,000 non-military HUs, 239,000 HUs required the assignment of within map spot numbers. The 239,000 HUs that required within map spotting were associated with 28,500 map spots. Table 11 below has the distribution of number of HUs at each map spot. The number of HUs per map spot range from less than 15 to 650. Two HUs per map spot could be a duplex.

Table 11 The 2020 PES IL Operation Number of HUs with Within Map Spot Number per Map Spot		
Number of HUs per Map Spot	Map Spot	
	Count	Percent
2	12,500	43.9%
3	3,100	10.9%
4	4,000	14.0%
5-10	4,800	16.8%
11-20	2,500	8.8%
21+	1,800	6.3%
Total Map Spots	28,500	100.0%
Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding.		
Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, PES MAFXs.		

- e. How many HUs were listed with both house number and street name, only house number, only street name, or neither? How many HUs had a unit designation?

In the LiMA, IL listers were instructed to input location address fields, including the house number and street name, for each HU. There were 514,000 stateside HUs listed from the IL operation, as shown in Table 12. Of these, 508,000 HUs (98.8 percent) had both house number and street name.

⁸ All military HUs were given a map spot of 9999.

Table 12 The 2020 PES IL Operation Address Fields for Stateside HUs (Excluding PR)		
Address Feature	Stateside HU	
	Count	Percent
House Number and Street Name ⁹	508,000	98.8%
House Number only	400	0.1%
Street Name only	4,700	0.9%
Neither House Number nor Street Name	1,300	0.3%
Total Stateside HUs	514,000	100.0%
Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding.		
Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, PES MAFXs.		

If there was more than one HU at a basic street address with the same house number and street name, the unit designation field was used to distinguish the difference between these units. Common examples of a unit designation are A, B, 1, 2, 101, and 102. Single-family homes that shared a property may have also had a unit designation. Most frequently, this field was used for multiunit structures. However, there were cases where there may have been more than one HU on a property that shared an address, this field was used to create a unique record for each HU on the ground. Table 13 shows the number of stateside HUs with a unit designation by the type of HU. Of the 514,000 stateside HUs, 225,000 HUs (43.8 percent) had a unit designation. Out of the 227,000 HUs in multiunit structures, 211,000 HUs (93.0 percent) had a unit designation. Whereas, out of the 268,000 HUs classified as single-family homes, only 7,800 HUs (2.9 percent) had a unit designation.

Additionally, Table 13 shows that of the 514,000 stateside HUs, 227,000 HUs (44.2 percent) were in multiunit structures. This percent is higher than the 38.3 percent in multiunit structures in the 2010 CCM (Argarin et al., 2012). The high percent of multiunit structures listed was to be expected since the PES oversampled large BCUs and renters for the IL operation with the intention to subsample before PI. PES subsampled HUs within large BCUs (containing 58 or more HUs) to produce a manageable PI workload and provide a more geographically diverse sample by interviewing in more BCUs.

⁹ Valid street name includes 50 addresses with some variation of "Unnamed Road."

Table 13
The 2020 PES IL Operation
Stateside HUs with Unit Designation by HU Type (Excluding PR)

Unit Designation	Multiunit Structure		Single-Family Home		Mobile Home or Trailer		Boat, Tent, Etc.*		Total Stateside HUs	
	Count	Column Percent	Count	Column Percent	Count	Column Percent	Count	Column Percent	Count	Column Percent
Yes	211,000	93.0%	7,800	2.9%	5,700	31.7%	60	13.3%	225,000	43.8%
No	16,000	7.0%	260,000	97.0%	12,500	69.4%	400	88.9%	289,000	56.2%
Total Stateside HUs	227,000	100.0%	268,000	100.0%	18,000	100.0%	450	100.0%	514,000	100.0%

*There was less than 15 cases missing an HU type. These cases were included in the "boat, tent, etc." category. Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding.
Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, PES MAFxs.

f. What was the total number of HUs listed on military installations?

There were additional procedures for IL listers who were assigned to work a military installation. Each military installation designated a point of contact to assist with the Census Bureau's visit to the installation. The lister canvassed the BCU in the same manner as a non-military BCU; however, there was no map spotting allowed on military installations. Out of the 532,000 HUs listed in IL, 1,400 HUs (0.3 percent) were listed on military installations. These 1,400 HUs were listed in 30 BCUs. There were no HUs listed on military installations in PR.

g. How many auxiliary maps were collected in the IL operation?

IL listers attempted to obtain auxiliary maps of apartment complexes and mobile home or trailer parks in their assigned BCUs from the manager of the facilities. An auxiliary map was a publicly available map of the facility provided by the facility's manager that helped the lister in canvassing the structure. The lister was instructed to personally canvass the entire multiunit structure even if an auxiliary map was provided. If the lister obtained an auxiliary map, the map was provided to the clerical matchers at the National Processing Center. These maps were then used in the matching operation to confirm the location of the units. Table 14 has the total auxiliary maps collected. Only 80 BCUs (0.8 percent) selected for IL had auxiliary maps.

Table 14 The 2020 PES IL Operation Auxiliary Maps Collected in the IL Operation				
	Count of Auxiliary Maps Collected	IL BCUs with Auxiliary Maps		Total IL BCUs
		Count	Percent of Total IL BCUs	
Total	200	80	0.8%	10,000
Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding. Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, Auxiliary Tracking file.				

h. What was the production rate (i.e., HUs listed per hour)?

IL listers and CFSs were the two staffing positions working IL production and IL QC in the field. IL listers were responsible for listing HUs and collecting address information by canvassing BCUs in their assigned geographic areas. Each CFS supervised a team of PES IL listers.

For this question, production rate was defined as the effort required to complete a single unit of work in terms of fieldwork (non-training) hours. A single unit of work was defined as the completion of listing an HU. Table 15 provides the budgeted and actual fieldwork hours by IL production and IL QC and positions (lister and CFS). There were 183,394 total budgeted hours and 116,823 actual hours in IL production. There were 33,752 total budgeted hours and 17,368 actual hours in IL QC. The actual hours for CFS were higher than the budgeted hours for both IL production and IL QC. The number of expected HUs and actual HUs from IL production (before IL QC) was 579,106 HUs and 529,255 HUs, respectively. The expected IL QC workload was lower than the actual workload, 86,866 HUs and 97,500 HUs, respectively.

Table 15 The 2020 PES IL Operation Total Budgeted and Actual Fieldwork Hours by IL Production and IL QC and Position (Including Stateside and PR)			
Position	Budgeted Fieldwork Hours	Actual Fieldwork Hours	Difference of Budget to Actual Fieldwork Hours
IL Production			
Total IL Production	183,394	116,823	66,571
Lister	164,234	84,158	80,076
CFS	19,161	32,665	(13,504)
IL QC			
Total IL QC	33,752	17,368	16,384
Lister	30,226	11,846	18,380
CFS	3,526	5,522	(1,996)
Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding. Source: U.S. Census Bureau, PES IL Cost and Progress Tables and Decennial Budget Office Estimates.			

Table 16 shows the IL and IL QC production budgeted and actual productivity rates. For IL production rate, 3.2 HUs were expected to be listed per hour (i.e., 579,000 HUs/183,394 hours), while 4.5 HUs were actually listed per hour (i.e., 529,000 HUs/116,823 hours). This was 1.4 more HUs listed per hour than expected. During IL QC, 5.6 HUs were completed per hour. This was 3.0 more HUs worked per hour than expected.

Table 16 The 2020 PES IL Operation Total Production Rate by IL Production and IL QC and Position (Including Stateside and PR)						
Position	Budgeted HUs to be Worked	Actual HUs Worked	Budgeted Fieldwork Hours	Actual Fieldwork Hours	Budgeted Production Rate (HUs/Hr)	Actual Production Rate (HUs/Hr)
IL Production	579,106	529,000	183,394	116,823	3.2	4.5
IL QC	86,866	97,500	33,752	17,368	2.6	5.6
Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding. Source: U.S. Census Bureau, PES IL Cost and Progress Tables and Decennial Budget Office Estimates.						

- i. What was the number of field staff (listers and CFSs) planned and actual number of field staff hired and trained?

The Field Division planned for an upper limit for hiring in each RCC. RCC staff were able to hire for each position at their discretion based on their regional implementation plans for IL production and IL QC. Staff were hired and trained before the start of the operation based on where people were needed geographically. Table 17 shows the numbers of staff planned and the actual staff hired and trained for IL production and IL QC. The total staffing planned number was higher than the actual staffing number for the combined IL production and IL QC, 1,900 people and 1,800 people, respectively.

Table 17 The 2020 PES IL Operation Field Staffing Level: Planned and Actual (Including Stateside and PR)							
Staffing	IL Production			IL QC			Total IL Production and IL QC
	Lister	CFS	Total	Lister	CFS	Total	
Actual Hired and Trained	1,400	200	1,600	200	N<15	250	1,800
Planned	1,400	150	1,600	250	30	300	1,900
Difference of Actual Staff Hired and Trained to Planned	20	40	20	(40)	(N<15)	(60)	(40)
Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding. Source: U.S. Census Bureau, 2020 PES Independent Listing Operation, PES IL and IL QC staffing report, Decennial Budget Office Estimates.							

- j. What was the summary of the IL QC component?

QC Listers worked 2,200 BCUs and 97,500 HUs in QC. Of the HUs worked in QC, all but less than 15 of them were received by SMarCS.¹⁰ The expected sample size for HUs to be worked during QC was 15.0 percent. The actual proportion of HUs worked was 18.4 percent, which included units that were added during production. The QC workload was based on the selection of BCUs and not the selection of HUs, which accounts for the difference in expected versus actual number of HUs. BCUs in the high sampling stratum failed at a rate of 52.1 percent, while BCUs in the middle and low strata failed at a rate of 46.3 percent and 34.4 percent, respectively. If the BCU failed QC, then the QC lister recanvassed the entire BCU.

SMaRCS selected 22.0 percent of all IL production BCUs and 22.0 percent of eligible BCUs for QC. Table 18 shows the total count and percentage of BCUs eligible and selected for IL QC. In the event a QC lister could not access the property, the QC lister marked the HU as unable to work (UTW). Note that the 40 BCUs marked UTW or BCUs containing HUs marked UTW were not eligible for QC.

Additional results from the IL QC will be documented separately in the forthcoming *2020 Census Post-Enumeration Survey Independent Listing Quality Control Results Memo*.

Table 18 The 2020 PES IL Operation Summary of BCUs Eligible and Selected for IL QC (Including Stateside and PR)			
	Count	Percent of IL Production BCUs	Percent of BCUs Eligible for QC
Total IL Production BCUs	10,000	100.0%	
BCUs Eligible for QC	10,000	100.0%	100.0%
BCUs Not Selected for QC	8,000	80.0%	80.0%
BCUs Selected for QC	2,200	22.0%	22.0%
Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding.			
Source: U.S. Census Bureau, 2020 Census Independent Listing operation.			

- k. What percentage of IL listers had at least one BCU checked in IL QC? What was the distribution of the count of failed BCUs by number of IL listers?

During IL production, 1,400 IL listers completed at least one BCU. Of these IL listers, 950 IL listers (67.9 percent) had at least one BCU checked in QC. 400 IL listers (28.6 percent) had no BCUs selected for QC.

Table 19 shows counts of IL listers with at least one BCU checked during QC by the number of BCUs that failed QC. 36.8 percent did not have any failures and 36.8 percent had one BCU fail.

¹⁰ Less than 15 HUs worked in IL QC were never returned to SMarCS.

Table 19 The 2020 PES IL Operation Distribution of IL Listers by Number of BCUs that Failed QC for IL Listers with at Least One BCU Checked in IL QC* (Including Stateside and PR)		
	Count of IL Listers With At Least One BCU Checked	Percent of IL Listers With At Least One BCU Checked
IL Listers With At Least One BCU Checked During QC	950	100.0%
Number of BCUs Failed		
0	350	36.8%
1	350	36.8%
2	150	15.8%
3-6	80	8.4%
7+	N<15	0.0%
*12 additional IL listers had BCUs selected but resulted in outcomes of Could Not Finish or UTW. Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding. Source: U.S. Census Bureau, 2020 Census Independent Listing operation.		

2. Schedule and cost results

- a. How did actual start and completion dates compare with planned start and completion dates?

The IL operation milestone dates were provided by the 2020 PES Integrated Master Schedule maintained by the Decennial Census Management Division (DCMD). The IL production was conducted on schedule from January 16 to March 13, 2020. Similarly, the IL QC was conducted on schedule from January 23 to March 20, 2020 (see Table 20). The IL production and IL QC schedules were not affected by the COVID-19 pandemic.

Table 20 IL Operational Schedule				
Operation	Planned Start	Actual Start	Planned Finish	Actual Finish
IL Production	01/16/2020	01/16/2020	03/13/2020	03/13/2020
IL QC	01/23/2020	01/23/2020	03/20/2020	03/20/2020
Source: U.S. Census Bureau, 2020 Census, Integrated Master Schedule				

- b. Were the IL production and IL QC over or under budget?

Table 21 shows the budgeted and actual cost (excluding training) by position for both IL production and IL QC. We overbudgeted for both IL production and IL QC, overall. These estimates were based on 2010 rates, which was a paper operation with a higher workload. The IL production total cost was about \$4,050,676. This was 24.9 percent under budget. Similarly,

the IL QC total cost was about \$649,694. This was 43.4 percent under budget. However, the actual costs for CFSs were higher than the budgeted costs for both IL production and IL QC.

With 10,000 BCUs and 529,000 HUs listed in IL production, the cost per BCU was \$405.07 and the cost per HU was \$7.66. In 2010, the cost per HU in IL production was \$12.36. For the IL QC workload, there were 2,200 BCUs and 97,500 HUs, which means the cost per BCU for IL QC was \$295.32 and the cost per HU for IL QC was \$6.66. In 2010, the cost per HU in IL QC was \$11.42.

Table 21			
The 2020 PES IL Operation			
Total Budgeted and Actual Cost by Position (Including Stateside and PR)			
Position	Budgeted Total Cost	Actual Total Cost	Difference of Budgeted to Actual Cost
IL Production			
Total IL Production	\$5,394,577	\$4,050,676	\$1,343,901
Lister	\$4,793,859	\$3,041,884	\$1,751,975
CFS	\$600,718	\$1,008,792	\$(408,074)
IL QC			
Total IL QC	\$1,147,608	\$649,694	\$497,914
Lister	\$1,020,880	\$476,984	\$543,896
CFS	\$126,728	\$172,710	\$(45,982)
Percent may not add to 100 percent because of rounding. Counts may not sum correctly because of rounding.			
Source: U.S. Census Bureau, PES IL Cost and Progress Tables and Decennial Budget Office Estimates.			

3. Lessons Learned by the PES IPT

a. What would the PES IPT change about the implementation of the 2020 PES IL operation?

There were several lessons learned during 2020 PES IL operation, which led to suggestions for research and potential changes to the 2030 IL operation. The following list of lessons learned was derived from the IPT and from field's debriefing reports:

- It was not clear to the IL listers how to correct data that was erroneously input into LiMA. This may have created discrepancies in the data. Classroom training and LiMA user manuals should address this issue.
- IL classroom training materials need more scenarios, examples, and role play activities. Training should include multiple practice listing scenarios to complete as a class.
- More time is needed to practice using the laptops and getting familiar with them in class, possibly adding at least an extra day to the in-class session.

- There were some issues with the LiMA, one of which was the functionality of the You Are Here Indicator (YAH) feature. It did not always give an accurate indication of where the lister was. More LiMA training in the classroom sessions, possibly a trainer-led LiMA demonstration followed by a question-and-answer session, should be included in the training. Going over a few practice IL cases using LiMA would also be beneficial.
 - Field staff wanted more explanation of the role or purpose of IL in the 2020 Census process and how it fits into the big picture during training and in the training materials. Respondents wanted to know this information, but the field staff felt unprepared to answer respondents' questions.
 - The technical soft launch was planned late. Some system teams were unaware that a PES soft launch was happening until the week it occurred. A more organized soft launch will benefit future PES operations. All system teams should be made aware of the details of the PES soft launch as soon as it is planned. Not only do they need to know when the soft launch will occur, but what the plan for this soft launch is and what environments they will be using.
 - SMaRCS was not ready and was paused early in the IL operation. For future PES IL QC, the QC system should be in place before the start of the operation to prevent a backlog of cases. This will help ensure that any mistakes made by the IL listers can be corrected in a timely manner.
 - Since we implemented a QC sampling strategy that did not check a portion of every BCU, some listers did not have any work checked during QC. This was mitigated by the fact that the BCUs that were determined to be more difficult were sampled at 100 percent rate. For future operations, we should consider sampling one of the first three eligible BCUs for each lister. This would ensure every lister is checked at least once in QC.
- b. What major challenges does the PES IPT foresee affecting the implementation of the IL operation in the future?

The future technology advancements will require the listing devices to be updated to adapt. If the listing devices do not keep up with the changing technology, the data collection will be inefficient and potentially inaccurate. To make any updates to the listing device, the PES will need additional funding. Without proper funding, the quality of the IL data would suffer.

6. Conclusions and Recommendations

In this section, we summarize the results of the IL operation (IL production and IL QC). These results are from the operational standpoint and are not the final PES estimates of coverage.

6.1 Conclusions

The 2020 PES IL operation was managed from six RCCs. The IL production was conducted on schedule from January 16 to March 13, 2020. IL QC was conducted on schedule from January 23 to March 20, 2020. The COVID-19 pandemic did not affect the dates of the IL operation.

The IL production workload was 10,000 BCUs in total, with the stateside workload of 9,800 BCUs (98.0 percent) and the PR workload was 400 BCUs (4.0 percent). Of the 10,000 BCUs, 1,700 BCUs (17.0 percent) had zero HUs listed. The expected number of HUs to list was 579,000. There were 532,000 HUs listed from stateside and PR at the end of the IL operation. 514,000 HUs (96.6 percent) were listed in stateside and 18,000 HUs (3.4 percent) listed in PR. Out of the 532,000 HUs listed, 1,400 HUs (0.3 percent) were listed on military bases. These 1,400 HUs were listed in 30 BCUs. There were no HUs listed on military installations in PR.

Each HU in LiMA was marked with a map spot to identify the location. If there was more than one HU at a map spot, the HU was given a within map spot number. Out of the 530,000 non-military HUs, 239,000 HUs required within map spotting.

IL listers attempted to obtain auxiliary maps of apartment complexes and mobile home or trailer parks in their assigned BCUs. There were 200 total auxiliary maps collected from 80 BCUs during the IL operation.

Out of the total 10,000 BCUs, 22.0 percent were expected to be small, 46.0 percent were expected to be medium, and 34.0 percent were expected to be large. However, the actual percent of small BCUs from IL was 23.0 percent, the percent of medium BCUs was 51.0 percent, and the percent of large BCUs was 29.0 percent.

During IL, listers asked the respondent at each single-family home and mobile home or trailer if there were any other HUs at the address. "At (address), are there any basement or garage apartments, trailers, or other residences, even if no one is living there now?" With this coverage question in the LiMA, PES aimed to capture those additional HUs that were not clearly marked for the IL listers. Of the respondents at 296,000 HUs that were asked the coverage question, 5,700 respondents responded "Yes." Of the respondents that responded "Yes," 33.3 percent had three or more additional attached units, 10.5 percent had two additional attached units, 56.1 percent had one additional attached unit, and 0.4 percent had additional detached unit(s).

Of the 514,000 stateside HUs listed from the IL operation, 508,000 HUs (98.8 percent) had both house number and street name fields captured in the LiMA. About 225,000 HUs (43.8 percent) had a unit designation indicating that there was likely more than one HU at a basic street address with the same house number and street name. Out of the multiunit structures, 93.0 percent had a unit designation. Only 2.9 percent of the single-family homes had a unit designation.

There were 1,900 IL production and IL QC staff planned for the operation, and 1,800 were hired and trained for IL production and IL QC (i.e., 94.7 percent of the planned staffing number was hired and trained).

The IL operation was estimated to cost \$5,394,577 for IL production and \$1,147,608 for IL QC. IL production was under budget by \$1,343,901 (24.9 percent) and IL QC was under budget by \$497,914 (43.4 percent). These estimates were projected based on 2010 productivity rates and workload counts. In 2020, the productivity rates were higher, in part because the 2010 IL was a paper operation. Additionally, the HU workload assumption was larger than the actual number of HUs in 2020 IL.

QC listers worked 2,200 BCUs and 97,500 HUs in IL QC. The 2,200 BCUs were 22.0 percent of all IL production BCUs. The expectation was for 15.0 percent of the HUs worked in IL production to be worked during QC. The number of HUs worked in QC, including HUs added during QC, was 18.4 percent of the number of HUs worked in production.

6.2 Recommendations

Based on the goals and scope of the PES IL operation (IL production and IL QC), high-level recommendations for the 2030 PES and beyond are:

1. The IL lister training needs to include more examples and difficult scenarios. Training should also clarify how to correct erroneous data entry into the listing device. Listers were unable to go back and edit their entries if they realized later there had been a mistake.
2. There should be a follow-up question asking if the additional residence is attached, detached, or both for the IL coverage question, “At (address), are there any basement or garage apartments, trailers, or other residences, even if no one is living there now?” It would also be helpful to ask how many additional HUs are at the address.
3. The listing device should be thoroughly tested to resolve any defects.
4. The procedure of collecting paper auxiliary maps should be removed for the 2030 PES because of the low volume collected in the 2020 IL operation. Collecting and processing paper maps of varying sizes requires significant resources, and these maps were rarely used. Allowing listers to take and upload pictures or images into the listing instrument may be a more economical option.
5. Increase the flexibility of QC sampling and monitoring. To help identify and correct some of the potential data quality and QC workload issues, should implement methods and systems that allow changing the QC sampling parameters as needed. Parameters should be easily changed and not hard coded. There should also be flexibility to place specific BCUs into QC for special situations. For example, if a lister is suspected of making errors, then their entire workload could be placed into QC, or if a specific geographic area has a higher failure rate, more of that workload could be placed into QC. Future research on the best methods to provide more flexibility to QC sampling parameters to allow

monitoring teams to adjust parameters according to real-time data analysis is recommended.

6. Research is needed into ways to update either the listing instrument, the lister training, or both to help listers correctly identify the BCU boundaries. Listers working outside the BCU boundaries lead to increased workloads in the IHUFU and FHUFU operations as well as the clerical matching operations.

7. Review / Approval Table

The individuals or groups that appear in the table below have reviewed and approved this operational assessment report.

Role	Approval Date
Decennial Census Management Division (DCMD) Assistant Division Chief for PES	08/30/2022
Decennial Research Objectives and Methods (DROM) Working Group DROM Working Group	07/26/2022
Decennial Communications Coordination Office	01/20/2023

8. Document Revision and Version Control History

The table below includes entries for each major version of this operational assessment report along with a brief description of the version and any changes made to the preceding version.

Version/Editor	Date	Version Description/Revisions
1.0/Bernstein	01/20/2023	Final Version Approved for Public

9. Acknowledgements

Thank you to the Quality Assurance Branch in DSSD for providing information on the IL QC procedures and IL QC results.

10. References and Supporting Materials

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Appendix A: Glossary of Acronyms

Acronym	Definition
BCU	Basic Collection Unit
CFS	Census Field Supervisor
COVID-19	Coronavirus Disease 2019
DCMD	Decennial Census Management Division
DROM	Decennial Research Objectives and Methods Working Group
DSSD	Decennial Statistical Studies Division
FHUFU	Final Housing Unit Followup
GPS	Global Positioning System
HU	Housing Unit
IHUFU	Initial Housing Unit Followup
IL	Independent Listing
IPT	Integrated Project Team
KM/HM	Kilometer/Hectometer
LiMA	Listing and Mapping Application
MAF-TIGER	Master Address File – Topologically Integrated Geographic Encoding and Referencing
MAFX	Master Address File Extract
PES	Post-Enumeration Survey
PFU	Person Followup
PI	Person Interview
PR	Puerto Rico
QC	Quality Control
RCC	Regional Census Center
RV	Recreational Vehicle
SMaRCS	Sampling, Matching, Review and Coding System
U.S.	United States
UTS	Unified Tracking System
UTW	Unable to Work
YAHl	You Are Here Indicator